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(54) Rolling bearings

(57) The median of the zone of contact between a cage 15 and a row of rolling elements 13 of a rolling bearing is inside the cylinder or cone circumscribing the rolling axes of that row of rolling elements.

FIG. 2.

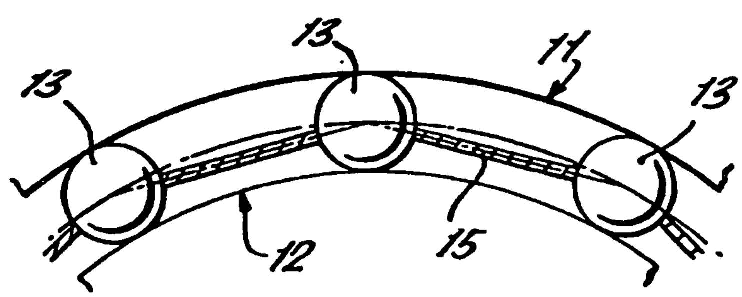

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FIG. 1.

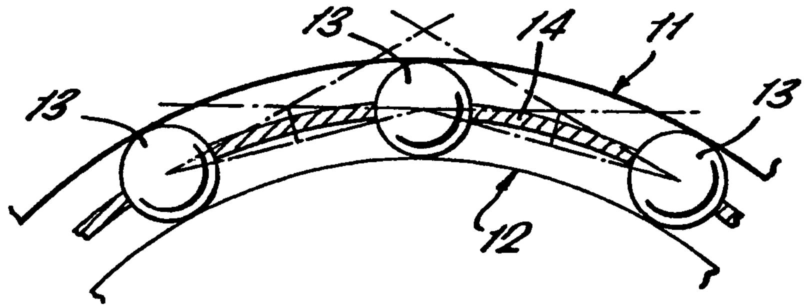


FIG. 2.

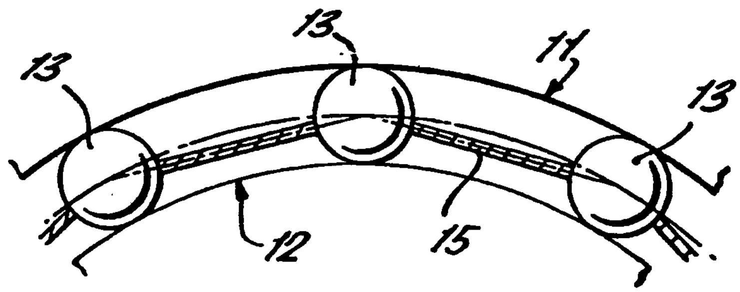


FIG. 3.

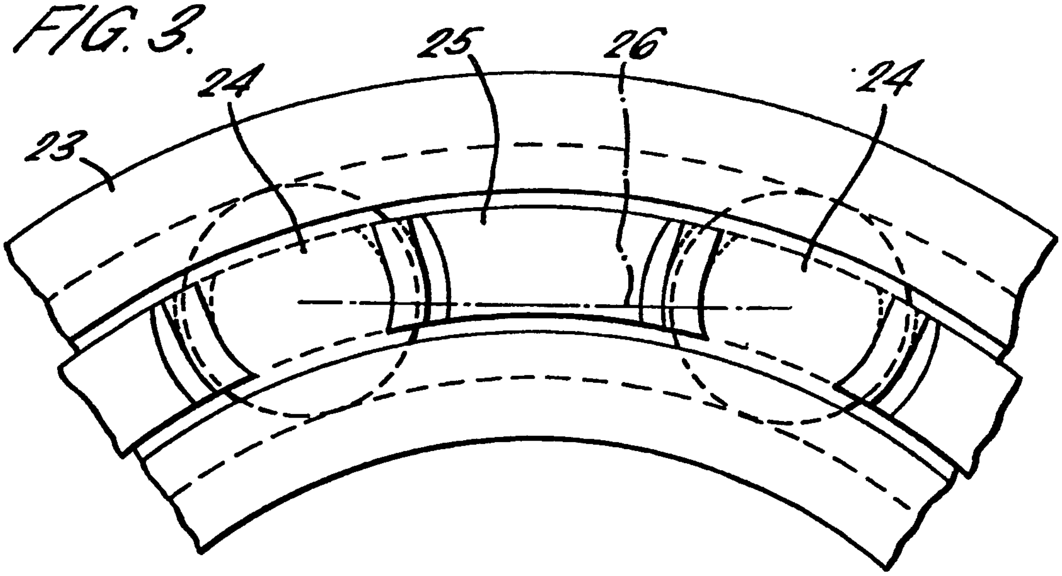


FIG. 3a.

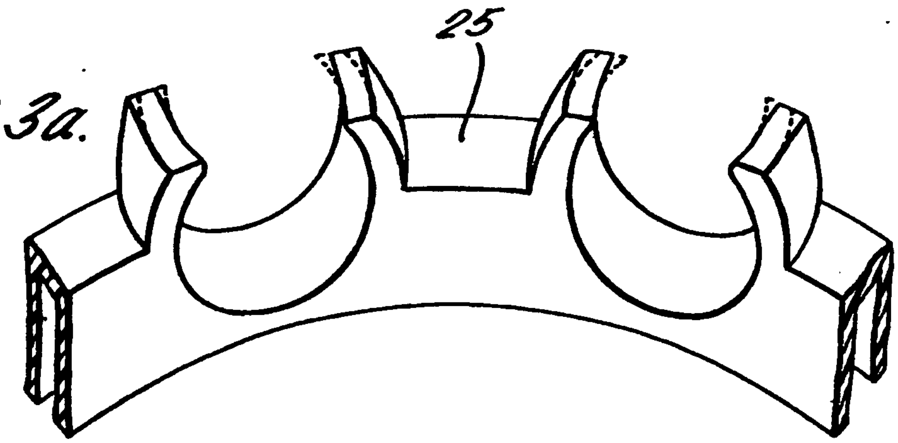
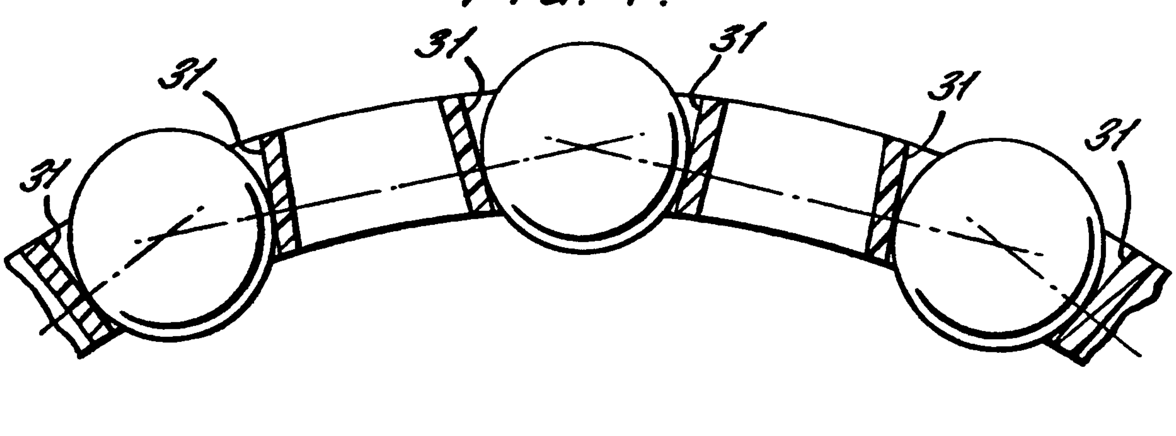


FIG. 4.



SPECIFICATION

Improvem nts in or relating to cages for rolling bearings and to rolling bearings

This invention is concerned with rolling bearings, such as ball or roller bearings, having cages to maintain a desired spacing of the rolling elements.

In optimum designed operating conditions, there is very little force at the contacts between the cage and the rolling elements. However, when a rolling element malfuctions (e.g. a roller skews or a ball jams) the force with which some or all the remaining rolling elements contact the cage is greatly increased since drive has to be transmitted from them through the cage to the malfunctioning rolling element.

When drive is so transmitted, the resultant loading of the cage may distort it and this may have undesirable results.

The object of the present invention is to reduce the extent of such distortion, and so of the undesirable results to which such distortion leads, without substantially increasing the rigidity of the cage.

Hitherto cages for rolling bearings have normally been designed so that median contact (i.e. contact at the median of the zone of contact) between the rolling elements and their cages, under normal operation, will occur at or outside a cylinder or cone circumscribing the rolling axes of the rolling elements when they have the designed spacing in the bearing.

The rolling axes will be circumscribed by a cylinder if the bearing is, for example, a radial ball bearing or a cylindrical roller bearing. They will be circumscribed by a cone if the bearing is, for example, a taper roller bearing or an angular contact ball bearing. The rolling axes of each row will be circumscribed by a cone if the bearing is a double row spherical bearing or a double row taper rolling bearing.

According to the present invention, the cage is so designed and dimensioned that, in use, median contact with each rolling element in a cage-pocket will occur within the cylinder or cone circumscribing the rolling axes of that row of rolling elements and preferably on a line joining the rolling axis of a rolling element in one cage pocket with the rolling axis of the adjacent rolling element in the same row in a cage pocket and that the case has a substantial ability to transmit force along such line.

In the accompanying drawings:—

Figure 1 is a diagrammatic scrap-radial section of a prior art cylindrical-roller bearing;

Figure 2 is a similar diagrammatic scrap radial section of a cylindrical roller bearing embodying the inv ntion;

Figur 3 is a scrap nd vi w of a deep-groove radial ball-bearing;

Figure 3a is a scrap perspective view of part of th case used in th construction shown in Figur 3; and

Figure 4 is a scrap section through three balls and the adjac nt parts of a cage of an ther de p-groove radial ball-bearing.

The bearing shown in Figure 1 has an outer bearing ring raceway surface 11 and an inn r bearing ring raceway surface 12. Between them and rolling on both of them there is a set of cylindrical rollers 13, of which three are shown. These rollers are located radially by the raceway surfaces and circumferentially by a cage 14. In normal operation the rollers have the designed spacing in the cage and their rolling axes are parallel to the axis of the raceway surfaces 11 and 12. The pitch circle of the cylinders lies in the cylinder circumscribing their rolling axes.

In normal designed use, one or more rollers 13 contact the appropriate side of a cage-pocket in which it is located to drive the cage in the direction in which it rotates. The force required at the contacts(s) is minimal in this condition.

When a roller malfunctions, force has to be transmitted to it through the cage tending to carry it round with the remainder of the row. One such malfunction for cylindrical roller bearings is a tendency of a roller to skew, i.e. adopt a position in which its axis of rotation is not parallel to the axis of the raceway surfaces 11 and 12. On skewing, the case has to push the skewing roller at one end in one direction and to oppose a push from it at the other end in the other direction, so as to apply a couple to the skewing roller tending to eliminate the skew. The correcting forces applying such couple, are transmitted through the cage. Further, the skewing roller may jam in the raceways and not roll on them and the cage has to transmit to the skewing roller sufficient force to overcome the friction between the skewing roller and the raceways.

The bearing shown in Figure 1 is a prior art bearing and the median contact of its cage with its rollers is at the pitch circle of the rollers. The result is that, when the cage has to transmit force to or from a roller, the line of action of such force, or its reduction, is tangential to the pitch circle. Thus when a roller malfunctions, there are forces applied to the cage along the tangents to the pitch circle from the malfunctioning roller opposing rotation of the cage and from an adjacent roller driving the cage to rotate. These forces are very much heavier than those applied to the cage to carry it round when all the rollers are operating normally.

The heavy forces thus generated are tangential to the pitch circle and have to be accommodated by the cage. They are equivalent to opposed forces between the centres of the rollers and a radial outwards force.

Unless distortion/displacement of the cage is to occur, the radial outwards force has to be accommodat d within th cag . This determines the choic of mat rial for th cag and the rigidity provided by the design of the cag .

The present inventi n enables a less inherently rigid mat rial to b used for a similar cage design or a less rigid cage to be designed from th same material or a choice of material and cag d sign

between these two extremes.

Referring now to Figure 2 the bearing is a cylindrical roller bearing having an outer b aring ring raceway surface 11, an inner bearing ring raceway surface 12 and a set of cylindrical rollers 13 rolling on both race surfaces.

In this embodiment, however, the cage 15 is polygonal and is designed so that the median contact with the rollers is not at the pitch circle but, inside the pitch circle, where the planes joining the centres of adjacent pairs of rollers intersect the surfaces of those rollers.

As a result, when heavy forces have to be transmitted through the cage between a malfunctioning roller and an adjacent roller, their lines of action do not produce a radial force distorting the cage, as is inevitable if median contact is at the pitch circle.

The result, for example, is that if the same material is used for the cages 14 and 15 a thinner and cheaper gauge can be used for the cage 15, since it does not have to withstand the radially outwards force which the cage 14 has to accommodate.

Figure 3 shows a deep-groove radial ball-bearing with inner bearing ring 22, outer bearing ring 23 and a set of balls 24 (only two of which are shown) rolling on both rings. The rolling axes of the balls are parallel to the axis of the bearing rings 22 and 23. The pitch circle of the row of balls lie in the cylinder circumscribing the rolling axes of the balls. The balls are radially and axially located by the raceways of the bearing rings and are circumferentially located by a cage 25, each ball being located in a pocket in the cage. The construction of the cage is more readily appreciated from Figure 3a. It is made of a plastics material.

The invention results in the shape of the pocket differing, as compared with the prior art. In the prior art, each pocket if fully spherical to obtain median contact between ball and pocket at the pitch circle of the row of balls.

In accordance with the invention, however, a ball and its pocket are not in contact outside the pitch circle to the same extent but are in contact over such zone that median contact in the circumferential direction is where the line 26 joining the centres of adjacent balls intersects the pocket. This is, of course, inside the cylinder circumscribing the rolling axes of the balls.

Both prior art and a construction according to the invention are indicated in Figures 3 and 3a. The difference is apparent mainly outside the pitch circle where the construction of the invention is shown in full lines and that of the prior art is indicated in dotted lines. In this figures, the construction according to the invention has the projections of each pocket from th body of the cage 25 with the inner and outer surfaces of the wall parall l to one another. In constructions according to th invention, this is not necessary.

The walls are not in contact with the balls outside the zone of contact and the median of this zone is inside the cylinder circumscribing the rolling axes f the balls (which cylind r is generated by a line parallel with the axis of the rolling surfaces of th bearing rings and rotating through the pitch circle of th balls). Outsid the zone of contact, material of the cage can be reduced e.g. by chamfering the outer surfaces of the projections to the position indicated for the prior art construction.

Figure 4 brings out the invention more clearly when compared with the prior art indicated in Figures 3 and 3a. Figure 4 is a scrap section through three balls of a deep-groove radial ball-bearing taken on a plane at right angles to the axis of the bearing and passing through the centres of the balls.

The cylinder circumscribing the rolling axes of the balls would intersect with this plane as a circle passing through the centres of the balls in the single row.

In this construction each pocket has surfaces 31 which, for each pocket, lie on a cone. The axis of the cone is radial to the axis of the bearing and passes through the centre of the ball which it contains. The cone angle of the cone is chosen, having regard to the diameter of the balls of the bearing in which the cage is to be used and to the spacing of the pockets, so that the ball contacts the pocket at a circle which is intersected by the lines joining the centre of the ball in the pocket with the centres of the balls in the adjacent pockets on either side. Thus the median contact is within the cylinder circumscribing the axes of rotation of the row of balls.

Cages in accordance with the invention can also be used with taper roller bearings, angular contact ball bearings, double row spherical roller bearings or double row taper rolling bearings, for example. In such bearings the body of revolution which circumscribes the rolling axes of a row of rolling elements is not a cylinder but a cone. When the invention is used in such a bearing, the median contact between a cage and each rolling element in a row of rolling elements is inside the circumscribing cone and is preferably intersected by a line joining the centres of adjacent rolling elements, if they are balls, or by a plane containing the axes of adjacent rolling elements if they are taper rollers or spherical rollers.

CLAIMS

1. A cage for a rolling bearing so designed and dimensioned that, in use, median contact between the cage and the rolling elements of a row when one is in pockets of the cage will occur only within the cylinder or cone circumscribing the rolling axes of that row of rolling elements.

2. A cage as claimed in claim 1 for a ball bearing wherein the median contact between the cage and a ball occurs nly in a plane intersecting with a line joining the rolling axis of that ball with the rolling axis of an adjacent ball in the same row and in a pocket of the cage and the cag has a substantial ability to transmit force along that line.

3. A cage as claim d in claim 2 and having conical pockets, the axis of each cone being radial

to the axis of the cag .

4. A ball bearing incorporating a cage as claimed in claim 2 or claim 3 and a row of balls in the pockets of the cage.

5. A cage as claimed in claim 1 for a roller bearing wherein the median contact between the cage and a roller occurs only in a plane containing the rolling axes of that roller and of an adjacent roller in the same row and in a pocket of the cage and the cage has substantial ability to transmit force in that plane.

6. A roller bearing incorporating a cage as claimed in claim 5 and at least one row of rollers in the pockets of the cage.

7. A cage for a cylindrical roller bearing substantially as h reinb for described with reference to and as shown in Figure 2 of the accompanying drawings.

8. A cylindrical roller bearing incorporating a cage as claimed in claim 7 and a row of rollers one in each pocket of the cage.

9. A cage for a ball bearing substantially as hereinbefore described with reference to and as shown in Figures 3 and 3a or Figure 4 of the accompanying drawings.

10. A ball bearing incorporating a cage as claimed in claim 9 and a row of balls one in each pocket of the cage.

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